Energy-Autonomous Sensor Node for Intelligent Infrastructure

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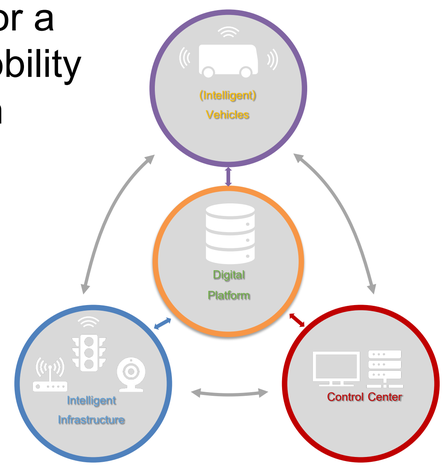
Overall Project

- **A**utomatisiertes und vernetztes Fahren in der **L**ogistik am Testfeld **Fried**richshafen (ALFRIED)
- Objective: To develop the basis for a connected, digitally controlled mobility system, with a particular focus on inner-city goods traffic
- Mobility system
  - Intelligent vehicles
  - Intelligent infrastructure
  - Digital data platform
  - Smart city control center

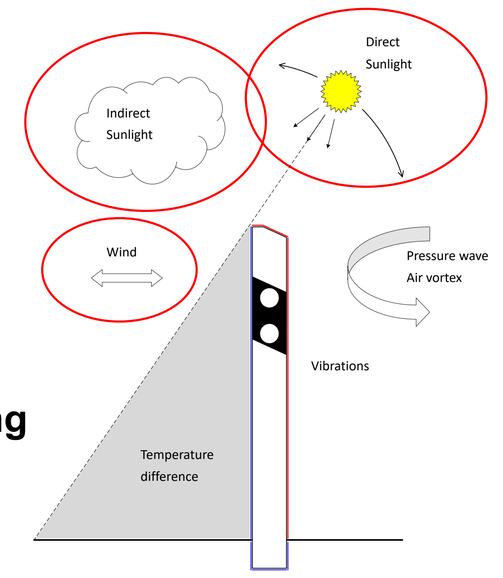


Multimodal Energy Harvesting System

Energy Sources
- Light (direct, indirect)
- Wind
- Battery Pack

Energy Converter
- Photovoltaic panels
- Electromagnetic wind turbine

Maximum Power Point Tracking (MPPT)
- Custom design, as not commercially available



Photovoltaics

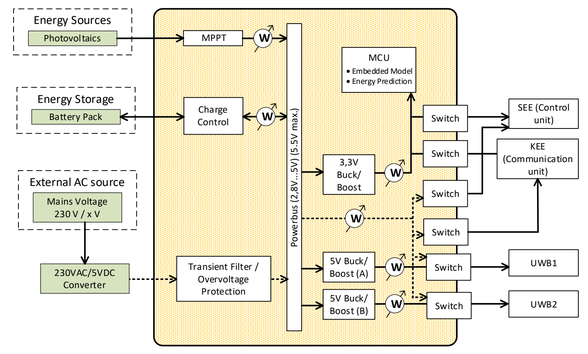
Challenges
- Different radiation intensities on different partial surfaces
- Systemically different operating point per side
- Site-related differences within a side
- Vegetation or snow
- Local soiling, shadows

Implemented solutions
- White solar panels from SOLAXESS on three sides 7.5 W max. in total
- Separate MPPT per panel

Power Management & Battery Pack

Challenges
- High power requirement due to sensors
- Operation at -20°C to 80°C
- Lithium plating at high charging current and low temperatures
- Design for delineator shape

Implemented solutions
- LiFePO4 temperature-resistant, long service life > 1000 cycles
- Fuel gauge avoids lithium plating and increases service life

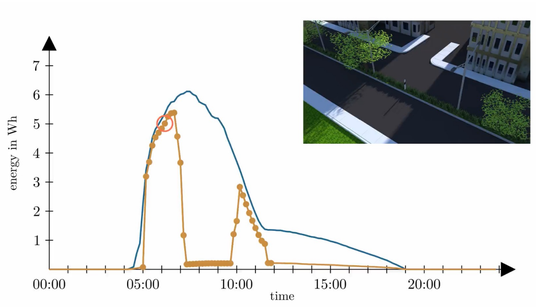


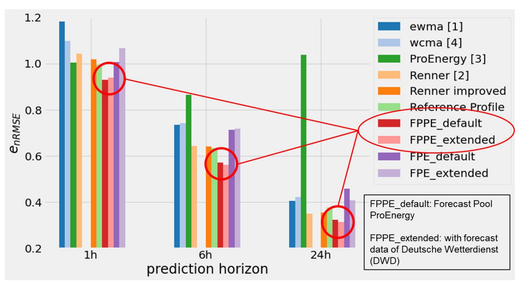
Energy Forecast

Motivation
- Energy prediction for scheduling the sensor on time

Challenges
- Angle of incidence
- Shading curves
- Diffuse and direct irradiation
- Weather influences

Goal
- Comparison and evaluation of the existing and our extended algorithms for energy forecast





Conclusions

- Photovoltaics promising up to 10 Wp, wind generators of this size/location only show low energy yield < 1 W
- Energy consumption of the UWB sensors several 10 W
  → Supply gap („energy starving“)
- MPPT not commercially available for broad power spectrum
  → Custom design
- ProEnergy is currently implemented for power prediction, FPPE_extended planned for future iterations
- Performance tests in real traffic are still pending

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